REMARKS

The Present Invention

The present invention relates to a polishing system and composition for use in polishing a substrate, particularly a multi-layer substrate that includes a first metal layer and a second layer. Claims 1-6, 11-31, 36-44, and 47-67 currently are pending.

Summary of the Office Action

The Office Action rejects claims 1, 3, 4, 11-19, 22, 24, 26-31, 36-40, 42, 44, 49, and 51 under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Patent No. 6,136,714 (Schutz et al.) (hereinafter "the Schutz '714 patent") in view of U.S. Patent No. 5,897,375 (Watts et al.) (hereinafter "the Watts '375 patent") or U.S. Patent No. 5,954,997 (Kaufman et al.) (hereinafter "the Kaufman '997 patent").

Discussion of the Obviousness Rejection

The Office Action rejects the pending claims as allegedly encompassing obvious subject matter in view of the Schutz '714 patent, the Watts '375 patent, and/or the Kaufman '997 patent. In particular, the Office Action asserts that the Schutz '714 patent discloses a system for polishing one or more layers of a multi-layer substrate, the system comprising a liquid carrier, a polishing additive (e.g., tartaric acid), a stopping compound (e.g., polyethylenimine), and an abrasive (e.g., alumina or silica). The Office Action acknowledges that the Schutz '714 patent fails to teach or suggest a polishing system comprising an oxidizing agent and at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings, but asserts that such a system would have been obvious in view of the Watts '375 patent or the Kaufman '997 patent. Applicants traverse the obviousness rejection.

The Schutz '714 patent is directed to a method for enhancing the removal rate of a metal barrier layer on a semiconductor substrate using a chemical-mechanical polishing slurry containing a chelating agent. The Schutz '714 patent more specifically provides that the chemical-mechanical polishing slurry contains a metal removal-enhancing amount of a chelating agent to enhance the removal rate of the metal barrier layer without affecting the removal rate of a conductive layer on the semiconductor substrate (see, e.g., the Schutz '714 patent at col. 2, lines 19-26). The Schutz '714 patent further provides that suitable chelating agents include polyphosphonates, aminocarboxylic acids, 1,3-diketones, trifluoroacetylacetone, thenoyltrifluoroacetone, hydroxycarboxylic acids (e.g., tartaric acid), polyamines, aminoalcohols, aromatic heterocyclic bases, phenols, aminophenols, oxines,

Schiff bases, tetrapyroles, sulfur compounds, synthetic macrocyclic compounds, polymeric chelating agents (e.g., polyethylenimine), and phosphonic acids (the Schutz '714 patent at col. 4, lines 5-35). While the Schutz '714 patent does provide the foregoing "laundry list" of suitable chelating agents, the Schutz '714 patent does not specifically disclose a chemical-mechanical polishing slurry comprising a combination of two or more of the aforementioned chelating agents, much less the combination of a carboxylic acid (e.g., tartaric acid) and a polyethylenimine.

Moreover, contrary to the Office Action's assertions, one of ordinary skill in the art, at the time of invention, would not have been motivated to modify the Schutz '714 patent in such a way as to arrive at the invention defined by the pending claims. In particular, one of ordinary skill in the art would not have modified the disclosed polishing slurries to include both a carboxylic acid polishing additive and a polyethylenimine stopping compound, as required by the elected species.

The accompanying Rule 132 declaration of Shumin Wang sets forth the conductive metal layer and metal barrier layer removal rates observed for polishing compositions comprising both a carboxylic acid and a polyethylenimine. As set forth in the declaration, a chemical-mechanical polishing composition comprising a carboxylic acid (e.g., tartaric acid) exhibits only a negligible increase in the metal barrier layer (e.g., tantalum) removal rate as compared to a similar chemical-mechanical polishing composition that does not comprise a carboxylic acid. Furthermore, a chemical-mechanical polishing composition comprising both a carboxylic acid (e.g., tartaric acid) and a polyethylenimine exhibits a conductive metal layer (e.g., copper) removal rate and a metal barrier layer (i.e., tantalum) removal rate that are significantly *lower* than the removal rate for a chemical-mechanical polishing composition comprising a carboxylic acid alone. Indeed, the metal barrier layer removal rate for such a chemical-mechanical polishing composition is approximately 90% *less* than the metal barrier layer removal rate observed for both the polishing composition comprising only a carboxylic acid and the polishing composition comprising neither a carboxylic acid nor a polyethylenimine. Thus, rather than increasing the removal rate of the metal barrier layer, the combination of a carboxylic acid and a polyethylenimine actually *suppresses* the removal rate of the metal barrier layer below that observed for a chemical-mechanical polishing composition comprising neither component (i.e., a "conventional" composition according to the Schutz '714 patent). Insofar as the Schutz '714 patent is specifically directed toward enhancing the metal barrier layer removal rate exhibited by "conventional" polishing compositions, one of ordinary skill in the art would not have been motivated to select and combine portions of the Schutz '714 patent in such a way as to produce a polishing

composition exhibiting a metal barrier layer removal rate that is less than the removal rate exhibited by "conventional" polishing compositions. Therefore, the Office cannot properly assert that one of ordinary skill in the art would have been motivated to modify the Schutz '714 patent in such a way as to arrive at a polishing composition comprising both a carboxylic acid polishing additive and a polyethylenimine stopping compound, as required by the elected species.

The Watts '375 and the Kaufman '997 patents do not remedy the deficiencies of the Schutz '714 patent. The instant application was filed on August 10, 2000, and claims priority to provisional U.S. Patent Application No. 60/148,813, which was filed on August 13, 1999. The Kaufman '997 patent (i.e., U.S. Patent 5,954,997) issued on September 21, 1999. Therefore, the Kaufman '997 patent only qualifies as prior art to the instant application under 35 U.S.C. § 102(e). However, the instant application and the Kaufman '997 patent were, at the time the invention of the instant application was made, owned by or subject to an obligation of assignment to Cabot Corporation, which subsequently assigned its rights to Cabot Microelectronics Corporation. Insofar as the instant application and the Kaufman '997 patent were commonly owned at the time the present invention was made, the Kaufman '997 patent does not qualify as prior art to the present application under 35 U.S.C. § 102(e) (*see* 35 U.S.C. § 103(c); *see also* M.P.E.P. 706.02(l)(2)).

The Watts '375 patent generally discloses a chemical-mechanical polishing slurry comprising an oxidizing agent, a citrate salt, 1,2,4-triazole or a triazole derivative, an abrasive, and a liquid carrier (see, e.g., the Watts '375 patent at col. 2, lines 26-37). As noted above, the experimental evidence set forth in the accompanying Rule 132 declaration clearly demonstrates that a polishing composition containing the combination of a carboxylic acid and a polyethylenimine exhibits both a conductive metal (i.e., copper) removal rate and a metal barrier layer (i.e., tantalum) removal rate that are significantly less than the removal rates exhibited by a similar polishing composition comprising only a carboxylic acid. Furthermore, the experimental evidence demonstrates that a polishing composition containing the combination of a carboxylic acid and a polyethylenimine exhibits a metal barrier layer (i.e., tantalum) removal rate that is significantly lower than the removal rate of a similar polishing composition that does not contain a carboxylic acid or a polyethylenimine. Insofar as the Watts '375 patent is directed toward increasing the removal rate of copper during the chemical-mechanical processing of a semiconductor (see, e.g., the Watts '375 patent at col. 1, line 66 – col. 2, line 8, and col. 2, lines 38-42), one of ordinary skill in the art, at the time of invention, would not have been motivated to combine the Schutz '714 and Watts '375 patents in such a way as to result in a polishing composition exhibiting a copper removal rate that is

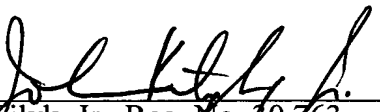
less than the copper removal rate of a polishing composition comprising only a carboxylic acid or a salt of a carboxylic acid. Therefore, the Office cannot properly assert that one of ordinary skill in the art would have been motivated to combine the Schutz '714 and Watts '375 patents in such a way as to arrive at a polishing composition comprising both a carboxylic acid polishing additive and a polyethylenimine stopping compound, as required by the elected species.

In view of the foregoing, the pending claims recite subject matter that is both novel and nonobvious over the disclosures of the Schutz '714, the Watts '375, and the Kaufman '997 patents, whether considered alone or in combination. The Section 103 rejection of the pending claims, therefore, should be withdrawn.

Conclusion

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,



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PATENT
Attorney Docket No. 98124X205843
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Wang et al.

Art Unit: 1765

Application No. 09/636,246

Examiner: Kin Chan Chen

Filed: August 10, 2000

For: POLISHING SYSTEM WITH STOPPING COMPOUND AND METHOD OF ITS USE

DECLARATION UNDER 37 C.F.R. § 1.132 OF SHUMIN WANG

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Commissioner for Patents
P.O. Box 1450
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I, Shumin Wang, hereby declare that:

1. I am a technology director employed by Cabot Microelectronics Corporation and one of the co-inventors of the subject matter disclosed and claimed in the subject patent application.

2. In order to illustrate both the separate and combined effects of a carboxylic acid and a polyethylenimine on the chemical-mechanical polishing of a substrate, an experiment was conducted to determine the removal rates for both a conductive metal layer (i.e., copper) and a metal barrier layer (i.e., tantalum) exhibited by polishing compositions containing (i) no carboxylic acids and no polyethylenimines, (ii) a carboxylic acid, (iii) a polyethylenimine, or (iv) a carboxylic acid and a polyethylenimine.

3. In particular, eight copper wafers and eight tantalum wafers were separately polished using one of eight different chemical-mechanical polishing compositions (Compositions 1-8). The copper and tantalum wafers used in the following polishing runs

consisted of copper blanket films and tantalum blanket films, respectively, deposited on a silicon substrate.

4. Each of the polishing compositions (Compositions 1-8) comprised about 3 wt.% of an alumina abrasive (i.e., Cabot's Semi-Sperse® W-A355 product) and 2.5 wt.% of an oxidizing agent (i.e., H_2O_2). The pH of each of the polishing compositions was adjusted to 7.7 using ammonium hydroxide. Compositions 1 and 2 did not contain a carboxylic acid or a polyethylenimine. Compositions 3, 4, 7, and 8 comprised about 1.25 wt.% of a carboxylic acid (i.e., tartaric acid). Compositions 5 and 7 comprised about 0.25 wt.% of Lupasol® FG, which contains about 25 wt.% of a polyethylenimine having an average molecular weight of about 800. Compositions 6 and 8 comprised about 0.25 wt.% of Lupasol® SKA, which contains about 25 wt.% of a polyethylenimine having an average molecular weight of about 2,000,000.

5. The copper and tantalum wafers were polished using an IPEC472 polishing machine and Rodel® IC1000 polishing pads stacked on Rodel® SUBA IV pads. The wafers were polished using a down force of about 20 kPa (3 psi), a back pressure of 0 kPa (0 psi), a table speed of 50 rpm, and a wafer holder speed of 30 rpm.

6. The copper and tantalum removal rates exhibited by each polishing composition were determined by measuring the thickness of the blanket film on each wafer, both before and after polishing, using a Tencor RS-75 resistivity mapping system. The copper removal rates and tantalum removal rates, in Angstroms per minute (Å/min.), exhibited by each of the polishing compositions are summarized in the following table.

Table. Copper and Tantalum Removal Rates for Compositions 1-8.

Composition	Carboxylic Acid	Polyethylenimine	Copper Removal Rate (Å/min.)	Tantalum Removal Rate (Å/min.)
1	--	--	87	198
2	--	--	196	327
3	1.25 wt.% Tartaric Acid	--	3173	133
4	1.25 wt.% Tartaric Acid	--	3361	224
5	--	0.25 wt.% Lupasol FG	560	8
6	--	0.25 wt.% Lupasol SKA	57	3
7	1.25 wt.% Tartaric Acid	0.25 wt.% Lupasol FG	2248	22
8	1.25 wt.% Tartaric Acid	0.25 wt.% Lupasol SKA	2212	19

7. As shown by the results, the polishing compositions comprising a polyethylenimine (Compositions 5 and 6) exhibited a marked *decrease* in the tantalum removal rate as compared to the polishing compositions that did not contain a polyethylenimine or a carboxylic acid (Compositions 1 and 2) and no observed increase or only a negligible increase in the copper removal rate as compared to the same polishing compositions.

8. While the polishing compositions (Compositions 3 and 4) comprising a carboxylic acid (i.e., 1.25 wt.% tartaric acid) exhibited a marked increase in the copper removal rate, the tantalum removal rates observed for the compositions was approximately equal to the tantalum removal rates observed for the polishing compositions which did not contain a polyethylenimine or a carboxylic acid (Compositions 1 and 2).

9. The polishing compositions (Compositions 7 and 8) comprising both a carboxylic acid (i.e., tartaric acid) and a polyethylenimine exhibited a *decrease* in both the copper and tantalum removal rates as compared to the removal rates exhibited by polishing compositions comprising only a carboxylic acid (i.e., tartaric acid). In particular, the copper removal rate observed for these polishing compositions (Compositions 7 and 8) was approximately 30% *lower* than the copper removal rate observed for the polishing

compositions comprising only a carboxylic acid. Also, the tantalum removal rate observed for these polishing compositions (Compositions 7 and 8) was approximately 90% *lower* than the tantalum removal rate observed for both the polishing compositions comprising only a carboxylic acid and the polishing compositions that did not comprise a carboxylic acid or a polyethylenimine.

10. I hereby declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: June 1, 2004

Shumin Wang